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METROPOLITAN SANITARY ASSOCIATION.

WATER SUPPLY

TO THE

METROPOLIS.

THE PART

OF THE REPORT

TO THE CITY COMMISSION OF SEWERS,

OF

JOHN SIMON, ESQ., F.R.S.

MEDICAL OFFICER OF HEALTH TO THE CITY OF LONDON,
AND ONE OF THE MEDICAL STAFF OF ST. THOMAS'S
HOSPITAL.

RELATING TO THE

SUPPLY OF WATER

TO THE POPULATION.

ISSUED BY THE COMMITTEE OF THE METROPOLITAN
SANITARY ASSOCIATION.

1851.

METROPOLITAN WATER SUPPLY

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TO THE CITY COMMISSIONERS OF SEWER

LONDON:

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JOHN SIMON, ESQ. F.R.S.

MEMBER OF THE COMMISSIONERS OF THE CITY OF LONDON,
AND ONE OF THE MEMBERS OF THE SEWERAGE
COMMISSION.

IN LONDON 1851

SUPPLY OF WATER

TO THE POPULATION

ISSUED BY THE COMMISSIONERS OF THE METROPOLITAN
WATER SUPPLY



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The Committee of the Metropolitan Sanitary Association, learning with regret that a very limited number of copies of the Report of the Medical Officer of Health for the City of London have been published, have reprinted the following Extract on Water Supply, as a valuable contribution to the information before the public.

January 21st., 1851.

WATER SUPPLY.

DURING the past year, as in the preceding one, I have given frequent consideration to the subject of water-supply within the City.

I have already endeavoured to convey to you the deep sense which I entertain of its importance, and I have every reason to believe that your Honourable Court recognizes, at its full weight, the necessity of providing for the City of London a supply of water which, in quantity, shall be ample, in quality pure, in distribution constant and accessible.

In my former Annual Report, and in some remarks subsequently addressed to your Committee of Health, I dwelt especially on such defects of our present system as relate to the quantity and distribution of water; endeavouring to illustrate the insufficiency of its supply to the poorer tenements of the City, and the extreme inconvenience which is entailed on their inmates, sometimes by dependence on a common tap, sometimes by the troublesome, expensive, and unwholesome necessity of storing water.

In reverting to this subject, I may correct a fallacy which is apt to prevail with respect to the abundance of supply. I have no reason whatever to doubt that a very liberal allowance of water is daily pumped into the City—enough, or more than enough, so far as I know, to fulfil all necessary purposes.

But those purposes are not fulfilled by it. A certain large figure is stated as representing the average quantity daily driven through the mains of the City; this quantity is divided by the number of residents within your area, and the inference is drawn that each individual inmate of the City has at his disposal 25 gallons a day; or (after deduction for public purposes and the like) $21\frac{1}{4}$ for his domestic supply. As an arithmetical conclusion from the premises this may be true; nothing can be less accurate as a practical representation of the facts. An average amount of three million gallons *per diem* may, or may not, be pumped through the mains of the City; but to calculate the *available water-supply* from this dividend, without previous deduction for the immense escape of *un-available water* by waste-pipes or otherwise, gives a most fictitious result. The large waste which naturally arises in the system of intermittent

supply has been well illustrated by some evidence given by Mr. Lovick before the late Metropolitan Commission of Sewers, in respect of a particular block of nearly 1200 houses. "Some of the houses were of the higher, and many of the poorer class, but the average might be stated to be of the middle class, and to present a fair example of an urban population. The drainage of all these houses was discharged through one main sewer. The run of water through this sewer was carefully watched and gauged every hour, during the night as well as the day, on days when the water was on, that is to say, when the intermittent supplies were delivered, and also on the ordinary days, when the consumption of the houses was from butts and cisterns, into which the intermittent supplies were delivered. The gaugings of the discharge of waste water into the sewer were checked by gaugings of the consumption of water from the butts and cisterns, during the intervals of the delivery of the supply by the company. It was ascertained that the average quantity discharged *per diem* through the sewers was $44\frac{1}{2}$ gallons per house; but it appeared that, on the days when the intermittent supplies of water were on, the quantity discharged *per diem* was 209 per house. The waste in this district from defects in house apparatus of distribution, incident to an intermittent supply of water, was, on the water days, three and three-quarter times greater than the consumption on those days."

No similar gaugings have, I believe, been made within the City; so I am unable to tell you with accuracy what are the proportions of waste and consumption. In an interview with your Committee on Health, when they were collecting information on the subject, Mr. Mylne, the engineer of the New River Company, stated (as a reason against fulfilling some object desired by the Committee) that within the City of London, in connection with its distributing apparatus, there existed for the escape and waste of water, during the period of supply, "at least 10,000 open cocks."

Assuming the accuracy of this statement, I doubt whether the average available supply of water for domestic purposes within the City, can possibly exceed a quarter of its alleged quantity; and I am persuaded that there must be large numbers of persons to whom the enjoyment even of that reduced average is utterly unknown. Your Honourable Court, observing the incalculable waste, and knowing that the cost of water-supply (as of all other commodities) must of necessity vary according to the quantity supplied, can appreciate the consequences of so much fruitless expenditure.

I would also beg likewise to observe to you, that this unapplied flood of water is in itself not unobjectionable. It would be of questionable advantage, if the drainage of the City were so perfect as to carry all away without inundation of the soil; while under opposite circumstances, in every quarter where drainage is absent or faulty, evil must arise from the extensive and habitual infiltration of moisture.

On the extreme inconvenience which attends the storage of water in the poorer habitations of the City, I have already reported to you, and will now only add that increased experience has given much confirmation to my view. Their receptacles are generally such as con-

tribute to the contamination of water, and are constantly so arranged as to invite an admixture of the most varied impurities.

In the large proportion of them, which are open casks, one sees habitually a film of soot floating on the surface; one sees (if, indeed, one can see so deeply into water which is often turbid and opaque) that filth and rubbish lie at the bottom; one sees the interior of the cask itself dirty and mouldering.

I now merely glance at this part of the subject, because you have already, on other occasions, allowed me to state my knowledge at greater length. But there is one evil in particular to which I would beg leave to advert. Those works of drainage which are established under your orders depend for their efficiency on a proper supply of water; and in every case where you enforce the construction of house-drains, you order that those drains shall be served efficiently with water. Your wishes on this subject are nominally complied with by those on whom your orders are served, but are often virtually evaded by a filthy and ineffectual contrivance. The butt or cistern of the house—that on which the inmates depend for their supply of fresh and pure drinking-water, is placed in immediate contiguity to the privy, so as to reduce the requisite length of connecting pipe to the fewest possible number of inches; the application of water is not made discretionary on the users of the privy, nor are any of the cheap and common self-acting contrivances introduced; but the waste-pipe of the butt or cistern is conducted into the discharge-pipe of the privy, so that, *periodically*, with a frequency varying according to the arrangements of the water-company, the arrears of excrement are removed, so far as the surplusage of the water-receptacle may have power to dislodge and propel them. Frequent evidence has been before me of the insufficiency of this arrangement; and, in addition to its actual failure (on the reasons of which your Surveyor can speak more competently than I) there is strong reason to object to its prevalence on other grounds. Water, as you probably know, is a very active absorbent of many gaseous materials; and the open butts, which are thus placed in immediate contact and communication with privies, must rapidly become infected by their foulness. I need not explain to you how injurious an addition this is to the other objectionable incidents of water-storage, or how unattractive as a beverage to the poor inhabitants of the City must be this vapid, privy-flavoured stuff.

For this arrangement I can suggest to your Honourable Court no alternative or remedy, so long as the distribution of water continues to be on its present intermittent plan: but it is matter for extreme regret that, by circumstances over which you have no control, the success of your sanitary measures should be seriously diminished. By the enforcement or execution of house-drainage, your Honourable Court has conferred great advantages on many districts of the City, but it is my duty to tell you that, in my judgment, the present condition of the water-trade contributes to neutralise those advantages, and constitutes a restriction on your power of doing good.

As respects the evils to which I have just adverted, unquestionably they admit of abatement by devoting separate water-receptacles to the very different uses of diet and drainage. But the expense of addi-

tional cisternage in tenements so poor cannot be considered trifling; and I believe that your Honourable Court would hesitate, even if you have the power, to enforce this double burthen on the owners of house-property, at a time when one may reasonably hope that the necessity for cisterns will be superseded.

There can be no doubt on the extreme degree in which it is desirable for the poor of the City of London, that water should be delivered to their houses on the principle of constant supply, and that they should thus be relieved from the expensive and unwholesome necessity of storing it in small quantities and in improper receptacles. That it is *desirable* is a certainty within my official knowledge, and on which therefore I can give an opinion of my own. That it is *practicable*, is not within my official knowledge; for in this part of the question are involved various considerations of hydraulic engineering, on which I am incompetent to offer an opinion. But I cannot ignore the fact that, in many parts of England and Scotland, the practicability of a constant supply has been evinced by the very conclusive evidence of its success. To some such instances I alluded in my last Report, and from the present year I can quote you a striking additional one. At Wolverhampton, in 1849, the system of supply, which had been previously intermittent, was made continuous. Instead of waste ensuing on the change, its immediate effect was a reduction of 22 *per cent.* on the quantity consumed. So great had been the unpopularity of the intermittent system of supply, that at the time of the change the company had not more than 600 customers. Immediately on the adoption of the new system, their customers increased, and within ten months had risen to 1400. This increase was continuing up to the date of the Report (May 4th, 1850), at which time they were adding to the number of their customers at the rate of 50 each week. The above facts (as is well observed by the resident engineer, Mr. Martin) may be taken as a fair test that the system of continuous supply is one of superior adaptation to the domestic wants of the public.

This case is but an inconsiderable fraction of the evidence which lies before the public on the subject of continuous supply. With such evidence before me, in contrast to what I observe of the distribution of water within the City of London, I cannot refrain from repeating to your Honourable Court my confirmed and deliberate opinion, that our method of supply is essentially bad, and that it withholds from the poorer population of the City a large proportion of those sanitary advantages which it is the object of water to confer. No doubt it will occur to you, that against evils of this nature—evils arising in the conflictive interests of water-buyer and water-seller, the first principles of commerce imply a resource; and that in this matter, as in others of the sort, a customer holds in his own hands the remedy for his dissatisfaction. But although the supply of water, in the hands of the powerful companies who vend it, is in many respects a common transaction of trade, and as such is in theory open to competition, yet I would beg to point out to your Honourable Court, that in regard of the City under your jurisdiction, no such check and no such stimulus as competition can virtually be said to exist. In every practical sense the sale of water is a monopoly. The individual

customer, dwelling in Cripplegate or in Farringdon, who is dissatisfied with his bargain in water, can go to no other market; and however legitimate may be his claim to be supplied with this prime necessary of life at its cheapest rate, in the most efficient manner, and of the best possible quality, your Honourable Court, hitherto, possesses no power to enforce it.

All who have given impartial consideration to the subject seem to concur as to the advantages which result from a control over the supply and distribution of water being possessed by those who are responsible for the drainage and cleanliness of a district. These different duties are in such essential relation to each other that they would seem almost of necessity to require a single direction and control. House-drainage pre-supposes water-supply; water-supply pre-supposes house-drainage; the efficiency of either implies their mutual adaptation, just as the circulation of blood within an animal body implies uninterrupted continuity of arteries and veins, each harmonising with the uses of the other, to ensure the efficiency of the whole. But while the works of drainage executed under your orders lose much of their sanitary usefulness for want of an effectual water supply, your Honourable Court has no power of interference in the matter, closely associated as it is with the performance of your other functions. These anomalies would be removed, and a most beneficial power over the distribution of water would be vested in the hands of your Commission, if in the renewal of your Act of Parliament, you procured authority to represent the citizens in this matter. All the advantages which could possibly be gained by competition, together with many benefits which no competition could ensure, would thus be realized to the population under your charge; if, namely, a clause were inserted in your Bill, empowering you, at your discretion, to contract corporately with any person or any company for the supply of water to the City of London.

In the Public Health Act (passed simultaneously with yours) an enactment of this nature exists, authorising local Boards of Health to "provide their district with such a supply of water as may be proper and sufficient," and for this purpose "to contract with any person whomsoever to do and execute all such works, matters, and things as shall be necessary and proper, and to require that houses shall be supplied with water," and to "make and levy water rates upon the premises, at a rate not exceeding twopence *per week*." With a power like this in your hands, you would easily enforce for the City of London whatever method of supply you might deliberately believe to be best; and you would then be enabled and entitled, in the application of other clauses in your Act, to require of landlords acting under your orders, a far completer, though less expensive, improvement of their property than you are yet in a position to obtain.

In submitting to your Honourable Court my views as to the expediency of your having a controlling power over the supply of water, I am glad to find myself supported by the recorded opinion of the present Lord Mayor, himself formerly the chairman of a commission of sewers; and I am induced to believe that such an addition to your functions might not be objectionable to the water companies, as I observe that Sir William Clay, the chairman of two metropolitan

companies, has expressed himself strongly on its "great and obvious convenience."

2. Of equal importance with anything which relates to the distribution of water are those momentous questions which relate to its *quality*, and which tend to determine its fitness for human consumption.

Considering the great share of public attention which these questions at present very properly obtain, the many projects which are broached for improving the quality of our metropolitan supply, and the importance of your being in a position to decide as to the merits of any plan which may affect the City of London, I have thought it desirable in this Report to submit to you some general observations on the subject. During the last few months, I have accordingly been collecting such information as might, in my judgment, be useful for this purpose. In pursuing one portion of my inquiry—that which relates to the chemical constitution of certain waters, I have availed myself of the permission of your Honourable Court to procure a limited amount of assistance from some one more conversant than myself with the practice of analysis. For this purpose I have addressed myself to Mr. Taylor, lately Lecturer on Chemistry at St. Thomas's Hospital, a gentleman in whose skill and impartiality I can implicitly trust. His account of the very careful analyses which he has made is subjoined to my Report. Concurrently with the experience of other chemists, it has furnished me with material for many of the conclusions which I am about to lay before you.

The water which is supplied by the New-River and East London Companies for the consumption of the City of London is substantially of one kind. The River Lea, on which the East London Company entirely depends, furnishes likewise much of the supply conveyed by the New River.* The springs in which the latter originate are of the same chemical kind as those which contribute to the Lea; and the artificial aquaduct runs its forty miles of course through much the same country as the natural river. Chemically, therefore, one description may apply to both; and I the rather speak of them conjointly, as any extension of its resources for our supply which the New River might obtain, would apparently be provided by increasing considerably its present draught from the Lea.

The pipe-water consumed in the City has for its general chemical character, that it contains a considerable quantity of carbonate of lime, held in solution by an excess of carbonic acid. To this and another salt of lime (the sulphate) the water chiefly owes the property which is complained of under the name of *hardness*: it is by reason of these salts, namely, that (if used as drawn) it decomposes a certain large proportion of whatever soap is used with it, and (till those salts are exhausted by a wasted proportion of soap, or by boiling or otherwise) prevents the formation of a lather, and hinders to that extent the

* It appears that the New River Company at present derives about two-thirds of its supply from the River Lea, and proposes to draw from this source a still larger proportion. Any chemical difference of quality in the City pipe-water (as between that supplied by the New River and that by the East London Company) would probably not exceed those limits of difference which prevail in respect of waters gathered *under varying circumstances* from one and the same source.

several purposes for which soap is employed. You are probably aware that soda is extensively used in the laundry, as an antidote to this objectionable quality of hard waters; and the excess of its employment tends, by corrosion, very observably to hasten the destruction of washing articles of dress. In the same measure as water possesses the property of decomposing soap, its utility as an universal solvent is impaired; it extends to various other substances which one seeks to dissolve in it (especially to many vegetable matters) the same disposition to waste them in the form of insoluble precipitates. Its conveniences for the purposes of cooking and manufacture are *pari passu* diminished.

Of the actual extent to which these disadvantages are sustained within the City of London, I have no means of forming an accurate opinion; but statements are before the public (from the general correctness of which I have no reason to withhold reliance and belief,) rating the pecuniary loss to the metropolis, in the two articles of soap and tea, at a very high figure. You will see from Mr. Taylor's observations the proportion in which waste occurs, as regards one of these articles; namely, that for the production of a lather in washing the pipe-water of the City of London, used without boiling, consumes from thirteen to nineteen times as much soap as distilled water would consume.*

The chemical constitution of these waters occasions another inconvenience. Their carbonate of lime is held in solution (in the chemical form of bicarbonate) by an excess of carbonic acid: under the influence of heat this excess is gradually disengaged and driven off; consequently, as they approach the boiling point, they begin to precipitate the earthy salt which that gas was instrumental in dissolving. Each gallon of water under these circumstances would deposit from ten to fifteen grains of earthy matter on the interior of whatever vessel might contain it, or on the surface of whatever solid—linen or mutton—might be contained in the boiler. Hence arises the well-known *furring* of vessels in which such waters have habitually been boiled.

I refrain from dwelling on the economical considerations which arise in these points of the subject, as very obvious inferences from the result of chemical analysis; and I pass to other matters more strictly within my own province of observation.

Is water thus constituted, in any degree detrimental to the health of those who drink it? It is not in a single word that this question

* It has been alleged that, by the use of soft water, the saving in soap would probably be equivalent to the whole of the money at present expended on water-supply; and that in the article of tea, the economy would amount to about one-third of the tea now consumed in the metropolis. It strikes me as possible, that, in forming these estimates, the argument may have proceeded too much from a consideration of the hardness of London waters in their un-boiled state; and that sufficient allowance may not have been made for the change which boiling produces. If boiling were prolonged for some hours before culinary or detergent use of the water, the results (for tea or soap) would be identical with those produced under the employment of soft water. Notoriously this precaution is not taken: but to avoid disputable ground, I confine myself to the *fact of considerable pecuniary loss*, arising from the cause in question, and I avoid any attempt to determine its exact amount.

can be fairly answered. Almost insuperable difficulty belongs to it, from the absence of any statistical method by which we might isolate the water-drinking portion of our population (a minority not defined in the census), and might compare them, in regard of the diseases to which they are liable, with similar sections of population in soft-water districts and in hard-water districts. Obviously, no other method of comparison can be unobjectionable; and, in arguing the subject from such materials as I have, I can pretend to nothing more than a rational approximation to truth.

Except in the comparatively few instances where active medicinal agents are naturally dissolved in a water, its effects (when injurious) would be so slow as to elude ordinary observation. If, as exceedingly probable, the same constitution of water as impairs its solvency out of the body, do likewise operate against its being the most eligible menstruum or dissolvent for processes occurring within the body—such processes I mean as attend the act of digestion; if the lime and other hardening ingredients which waste soap in our laundries, and tea in our parlours, do similarly waste within us those organic agencies by which our food is dissolved and converted; any result arising from this source would be of gradual operation, would not easily admit of being traced to its source, and (except in susceptible persons) would rarely produce such symptoms as might immediately draw attention to their cause. The ill effects (whatever they may be) arising from the use of hard waters must be looked for in chronic impairment of digestion, and in those various derangements of nutrition in distant parts (the skin and teeth particularly) which follow as secondary results on such chronic disorder. It would be ridiculous to look for the operation of an ill-chosen water, after its habitual use during two centuries, as though one were inquiring for the symptoms of an acute poison. The signs that are to be ascertained among a population, if such signs exist, are those which would evidence a premature exhaustion of the power of digestion, and would testify that the machine on which we depend for that power had been exposed to unnecessary and avoidable fatigue. This, I believe, is the utmost which medicine, proceeding from theoretical grounds, would venture to say on the subject.

Perhaps I need not inform you that indigestion, with all that follows from it, is so frequent in the metropolis, in persons after the first strength of youth, that, for large classes of society, a perfect discharge of the natural process of digestion (such a discharge of it as a lecturer would describe to be the exact type and intention of Nature) is exceptional and rare. Unquestionably, in large numbers of cases, wine, and beer, and spirits, have more than water to do with this effect. Unquestionably, other influences of metropolitan life—and, not least, the mental wear and tear which belong to its large excitement, contribute immensely to this chronic derangement of health; but there are reasons likewise for believing, that the quality of water consumed is not a matter of indifference to the result. We cannot but give it an important place among those influences of health or unhealth which we consider *local*; and we cannot refuse to recognise the fact, that in recommending our patients (as we do often recommend them) to try “change of air” for complaints which baffle

us by their obstinacy, so long as the subject of them remains in London, the course on which we rely for success implies "change of water," equally with that other change to which more popular importance is attached.

In illustration of this view, I may quote to you the experience of two other towns. Dr. Sutherland stated, in evidence before the General Board of Health, that having lived for a number of years at Liverpool (where the water is said to be of about the same degree of hardness as ours) he had long entertained a conviction that "the hard water, in a certain class of constitutions, tends to produce visceral obstructions; that it diminishes the natural secretions, produces a constipated or irregular state of the bowels, and consequently deranges the health. He had repeatedly known these complaints to vanish on leaving the town, and to re-appear immediately on returning to it, and it was such repeated occurrences which fixed his attention on the hard selenitic water of the new red sandstone as the probable cause, as he believed it to be, of these affections." (Rep. p. 51.) And Dr. Leach of Glasgow stated before the same Board, as the result in that town of two years' experience of a substitution of soft for hard drinking-water, that, in his opinion, "dyspeptic complaints had become diminished in number;" and that it had "been observed, since this change, urinary diseases have become less frequent, especially those attended by the deposition of gravel."

Inferences useful for ourselves cannot be drawn from statements like the above, on the fullest assumption of their accuracy, without comparing the waters referred to with our own, more completely than is done by the one characteristic of "hardness;" and there may likewise be other qualifications requisite for an application of the analogy. But those disorders of health which are specified by the gentlemen quoted, as produced by the use and diminished by the disuse of hard waters, are such as might very probably stand in the relation of effect to their alleged cause; results, namely, primary and secondary, of disordered digestion.

Practically, I may tell you, that there are many individuals whose stomachs are extremely sensitive to the impression of hard water, who derive immediate inconvenience from its use, and who refuse to drink it without artificial reduction of its objectionable quality. I may likewise inform you that a physician, recently deceased, whose knowledge of indigestion and its chronic effects (especially in relation to the skin and urinary organs) was most profound and accurate, and whose consulting practice in such disorders was for many years almost a monopoly (I mean Dr. Prout) was in the habit of enjoining on his patients the use of distilled water. He evidently considered that the consumption of such waters as are habitually drunk in the metropolis was detrimental, at least to an enfeebled digestion. This is an opinion which, I have reason to believe, is generally entertained by medical practitioners in London.

It may not be irrelevant to mention to you (since the influence of imagination or of artificial habits can have little to do with this result) that horses are liable to be much inconvenienced by hard water, if unaccustomed to its use; and it is, I believe, notorious that grooms in charge of racers habitually take the trouble of conveying with

them, to their temporary racing stables, a supply of the accustomed water. Veterinary surgeons say that under the continued use of hard water, which horses will avoid if possible, their coats become rough and staring;—an effect, I may observe, analogous to those skin disorders of the human subject which are apt to occur from impairment of the digestive functions.

Taking into account all these considerations, together with others of a more technical description; and believing that water is eligible for human consumption in proportion as it is free from the admixture of any material foreign to its simple elementary constitution—exception being made only of so much dissolved air as will render it sparkling and palatable; I entertain no doubt that a water, devoid of considerable hardness, would (*ceteris paribus*) for the purposes of cooking and beverage, be far preferable to that which the companies now distribute through the City of London.

Hitherto, however, I have spoken of the waters supplied to the City, merely as regards that large impregnation of earthy material which they gather from their source; and I have criticised them only in respect of that admixture. Their essential chemical quality is one native to the soil from which they are derived; and whatever censure thus far belongs to them could only have been avoided by the selection of a different source. Chemistry, in the days of Morrys and Myddleton, was not sufficiently advanced to inform the water merchants of a city on those different conditions which determine the fitness of a soil to serve as the natural or artificial *gathering-ground* of a supply, and by which (as they vary in different localities) hardness is imparted to the rain-fall of one district, while softness is preserved for that of another.

But there are other evils belonging to these waters, less appreciable indeed by chemistry, but open to universal observation, and meriting unqualified blame. They are conducted to the metropolis in open channels; they receive in large measure the surface-washing, the drainage, and even the sewage of the country through which they pass; they derive casual impurities from bathers and barges; they are liable to whatever pollutions mischievous or filthy persons may choose to inflict on them; and then on their arrival in the metropolis (after a short subsidence in reservoirs, which themselves are not unobjectionable) are distributed, without filtration, to the public. Whatever chemistry may say on this subject (and I need not remind you of very powerful causes of disease which lie beyond its cognizance) I cannot consider it matter of indifference, that we drink—with whatever dilution, or with whatever imperfect oxidation, the excremental and other impurities which mingle in these sources of our supply. Such admixtures, though in their *quantity* less, are in their *quality* identical with those which render Thames water, as taken at London Bridge, inadmissible for domestic consumption, and which occasion it, when stored for sea use, to undergo, before it becomes fit to drink, a succession of offensive changes strictly comparable to putrefaction.

In this slovenly method of conveyance and distribution there is a neglect of common precaution for the purity and healthfulness of the supply, which I must report to you as highly objectionable: and this—the method of supply to our great metropolis, strikes one the more

with astonishment and disgust, as one reflects on the long experience and admirable models which past centuries in foreign countries have supplied; and especially, as one remembers those colossal works which, more than two thousand years ago, were constructed under the Roman government, for the cool and cleanly conduction of water.

The present imperfections of knowledge forbid me to cite, as definite causes of disease, the contaminations to which I have adverted: I cannot say to you—pointing to our classified list of sickness and mortality, *this* depends on drinking the diluted drainage of Hertford, *that* on the contributions of Ware. Indeed I know that, under the influence of the river and the atmosphere, very considerable changes occur in the materials thus furnished, tending eventually to render them inert; and if injury to life occur from their ingestion, it is probably only under peculiar and exceptional conditions, increasing their quantity, or delaying their oxidation. In protesting against their continued distribution as articles of diet, I therefore insist less on inferences deducible from medicine, and shall probably have the concurrence of your Honourable Court in grounding my appeal on the common principles of taste.

On the incidental contaminations to which the pipe-water consumed within in the City becomes liable, by reason of its storage in receptacles both foul in themselves and surrounded by causes of foulness, I have already addressed you; and I have shown to you the dependence of this evil on the system of intermittent supply as adapted to the houses of the poor.

Of other sources of water-supply existing within the City of London, there are many of small extent in the form of superficial springs. These are eagerly sought after, sometimes from a distance, on account of their coolness, and sparkling condition. In the Appendix you will find an account of one of these waters, that in the vicinity of Bishopsgate church, which is very much drunk in that quarter of the City. Any praise given to it illustrates exceedingly the fallacy of popular judgment on such subjects, and shows how easily those qualities of coolness and freshness, which are absent from stored waters, impose on the palate, and induce a preference to be given to waters which are relatively most objectionable.

The chemical faults which belong to our London pipe-water are possessed in a far greater degree by this water of Bishopsgate pump, and the latter has moreover some vices which are absent from the former; but the vapidty and fustiness of water which has been stored in cisterns are so repugnant to the taste, that the water chemically preferable is not in practice preferred.

To the use of waters of this description, within a large City, there is always much objection. In addition to extreme hardness, which in London they universally possess, they are liable, in a dangerous degree, to become contaminated by the leakage of drains, and by other sources of impurity; as, for instance, where situated within the immediate vicinity of grave-yards, they derive products of animal decomposition from the soil.* Very recently, a celebrated pump

* This is illustrated in the analysis of Bishopsgate pump-water, given in my Appendix. The very large quantity of *nitrates*, there referred to that water, must be due to the oxidation of human bodies in the adjoining soil, which

within the City of London, that adjoining St. Bride's church-yard, has been abandoned on account of such impregnations. Or perhaps I should rather say (for the difference again illustrates the readiness with which the palate is deceived or corrupted) that it was not *abandoned*—for till almost the last moment the neighbours adhered to it with fondness; but the parochial authorities—alarmed by the proximity of cholera—caused its handle to be locked.

As an available source of supply to the City of London, the use of deep (Artesian) wells has been recommended: the clearness and softness of these waters, together with their freedom from organic matters, having concurred to suggest their employment. I feel bound to express the strongest opinion against the fitness of these waters for the purpose of beverage. They uniformly contain a considerable proportion of medicinal ingredients; they are capable of exerting definite and demonstrable influence over the natural actions of the body; and information is before me of various injury to health, affecting large numbers of persons, arising from the continued dietetic use of such waters.

In addressing your Honourable Court on the subject of Water-supply for the City, it is impossible that I should do otherwise than advert to the fact, that, during the last few months, under the auspices of her Majesty's government, as represented for sanitary purposes by the General Board of Health, a plan has been gradually maturing itself, for the supply of the entire metropolis with pure soft water. Founding itself on very extensive investigations as to the qualities of water, as to the influence of soils on its chemical composition, as to the relation between streams and rain-fall, as to the hydraulic principles of distribution, and the like, this plan proposes to gather water in certain silicious soils, which can impart to it the least possible admixture of foreign ingredients; to conduct it in closed channels, with every precaution for its perfect purity; and to distribute it throughout the metropolis, at a rate which shall be from thirty to fifty per *cent.* less than our present water-charges. The proposed area for the collection of this supply is in the extensive range of sandy soil in the south of Surrey, extending around Farnham, about ten miles in each direction. Since the publication of the first Report made on this subject, by the General Board of Health, unremitting inquiry has been advancing, under their direction, into all details of the plan; and the Honourable William Napier, who, with others, has been engaged in the investigation of the proposed sources, has advocated an important modification, which promises to reduce very considerably the anticipated expense of the undertaking. The essential and most important principles which governed the Board, in arranging their plan, were, first, to seek their supply in a silicious soil, where little soluble material could exist for its contamination; secondly, to take possession of the water so near to its source that all its original purity might be preserved; and, during conduction, to isolate it from those contaminations which are

serves in part as gathering ground to the spring. I should fear that, during rain-fall, this oxidation of organic compounds may not always have completed itself, and that materials of decomposition *still in progress of decay* may thus often be mingled in the water.

incidental to the onward passage of a stream through miles of promiscuous country. To fulfil these indications, there were two conceivable courses; and studious local inquiries could alone determine which of them was preferable: on the one hand, if the streams which represent the natural drainage of the country should be found uniformly pure and copious, they might admit of being conducted bodily into the artificial river of supply; on the other hand, it might be requisite to carry the interference of art still further, to absorb the filtering moisture of this large sand-district before it had become confluent into streams, and thus from day to day, by extensively ramified works of artificial sub-drainage, to derive immediately from the soil, the varying contributions of rain-fall and dew. The Board, apparently solicitous for the completer security of their plan, preferred to estimate its cost on the latter very expensive supposition; they allowed apparently for the diffusion of drain-pipes, over one hundred and fifty square miles of country, and for a reservoir which should contain storage of water equivalent to a very long metropolitan consumption. The latter examination, made by Mr. Napier, and confirmed by others, tends and appears to show, that these large sources of expense may be avoided; that the waters may be collected of unusual purity and softness where they have united themselves into rivulets of considerable volume; that the gauged and estimated discharge of these rivulets is sufficient day by day for the needs of the metropolis, according to the largest construction of those needs; that capillary drain-pipes and very extensive storage-room may thus be dispensed with; and that under the modification of arrangement suggested by these facts, some very large reduction might be inferred for the total estimate of this comprehensive plan.

Many of these particulars are already before the public; but in a matter of so much importance to the health of the City, as that of participating in a supply of pure water, collected and distributed on the soundest principles, and sold at the cheapest rate, I did not think it would become me, as your Officer of Health, to remain an indolent auditor. I have felt it my duty to inform myself, so far as I could, on the real merits of this scheme, and on its probable relation hereafter to the sanitary condition of the metropolis. I have spent three days on the site of the proposed sources, and many other days in informing myself on all the bearings of the subject. I have likewise collected water from a proposed tributary of the future supply, which has been analysed, and which shows (as my Appendix will illustrate to you) a remarkable and rare excellence. On one occasion of visiting the country, I was accompanied by Mr. T. Taylor, and we made on the spot a sufficient number of extemporaneous examinations, to assure us that the essential features, shown in the more elaborate analysis, are (as geological considerations would lead us to believe) the general characters of water throughout the district.

On any other than the sanitary relations of this subject I can have nothing officially to say; but, confining myself to these relations, I may certify to your Honourable Court that the water in question is in my judgment, of a quality admirably suited for domestic purposes; that its distribution through the City of London would conduce to the health and comfort of the population; and that the principles, proposed by the Board for its collection and conveyance,

appear to me such as sanitary science, in its present condition, should counsel for the water-service of the metropolis.

There is, however, one aspect of the subject which must not pass unconsidered. Water that is free from earthy ingredients requires a peculiar distributory apparatus. If conveyed in leaden pipes, with access of air, or if stored in leaden cisterns, it corrodes the metal of which they are composed, and is liable to derive from this source an impregnation very hazardous to life. Under certain circumstances, especially under alternations of air and water (such as occur in the intermittent supply) or where organic impurities are held in solution or suspension, or probably where from any cause uncombined carbonic acid is present, even the hardest waters are not free from this risk. Speaking generally, however, it affects soft water chiefly; distilled water most of all; and the Farnham water (in common with all pure water) is decidedly liable to this empoisonment, if used with leaden apparatus of conduction and storage. In my Appendix you will find some interesting particulars on this head; and you will observe that with experiments conducted by Mr. Taylor in imitation of the constant supply, (*i. e.*, with total submersion of the metal) the formation of carbonate of lead in the Farnham water was exceedingly gradual. This concurs with the alleged experience of Aberdeen, where it is said by Professor Clark to have been found (to my mind, by a somewhat dangerous trial) that pure and soft water, *distributed on the principle of constant supply*, does not exert on the leaden pipes any action injurious to the health of the population. You will likewise observe, that when hard water, as at present employed in the City, is softened by boiling, it acquires this property of pure water, and becomes capable of acting on lead; and here is an important observation, as it has been proposed by similar artificial means, employed on a very large scale, to soften all the water now distributed in the metropolis.

Obviously—as regards one and all of the many proposals for supplying water destitute of hardening ingredients—any chemical process, or any change of source, which might lead to the distribution of such pure water through the metropolis, could not be considered as a single and separate reform, but must be undertaken conjointly with such alterations in the distributive arrangements as might be requisite for removing from the new plan *any chance, however slight or remote, of injuring the population by metallic poison.*

What those alterations must be, it would now be premature to decide. The experience of Aberdeen might seem to suggest, that the system of constant supply (on all other accounts so eminently desirable for the metropolis) would in itself, if accompanied by the total disuse and prohibition of leaden cisternage, give sufficient security against the danger in question; or, on the other hand, further inquiry may show it to be quite indispensable for a safe distribution of the new supply, that leaden pipage should be entirely superseded by the use of some non-metallic material, as earthenware or glass. Should this change become necessary, its adoption would no doubt be facilitated by the comparative cheapness of these preferable materials.